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Upland Farming Division, Tohoku National Agricultural Experiment Station, Arai, Fukushima-City, Japan

Effect of grazing by *Sinella curviseta* (Collembola) on *Fusarium oxysporum f. sp. cucumerinum* causing cucumber disease

YOSHIO NAKAMURA, IWAO MATSUZAKI and JUSABUROU ITAKURA

With one figure

Synopsis: *Original scientific paper*

Sinella curviseta BROOK obtained from the rhizospheres of field-grown vegetables readily grazed on and multiplied by *Fusarium oxysporum f. sp. cucumerinum* OWEN. The insect suppressed the infection potential of *F. o. cucumerinum* causing *Fusarium* wilt of cucumber seedlings. In both the cases of their addition to the inoculated pot and to the sterilized pot together with the fungus agents, cucumber seedlings grew healthy and came into flower.
Key words: *Sinella curviseta, Fusarium oxysporum f. sp. cucumerinum*, cucumber disease, biological control.

1. Introduction

In the continuously cropped dryland of Japan, the cause of soil sickness is mainly soil-borne pathogens. The use of soil animals as a biological control for these pathogens has been reviewed by CURL (1988). Examples included the use of mycophagous Collembola, *Proisotoma minuta* (TULLBERG) and *Onychiurus encarpatus* DENIS to control *Rhizoctonia solani* KÜHN and *Fusarium oxysporum f. sp. vasinfectum* SNYDER et ATKINSON on cotton seedlings (CURL, 1979; WIGGINS & CURL, 1979), and *Onychiurus fimatus* GISIN and *Folsomia fimetaria* (L.) to control *Pythium ultimum* TROW on sugarbeet seedlings (ULBER, 1983).

The food preferences of several oribatid, enchytraeid and collembolan species for seven pathogenic fungal species have been tested and it was found that one oribatid species and several collembolan species grazed on their air-borne fungal mycelia (MATSUZAKI *et al.*, 1990; MATSUZAKI, 1991; NAKAMURA *et al.*, 1991). In the present report, the effect of a collembolan species, *Sinella curviseta* BROOK, on *Fusarium oxysporum f. sp. cucumerinum* OWEN, a pathogen causing *Fusarium* wilt in cucumber, was investigated.

2. Material and method

2.1. Experimental organisms

Specimens of *Sinella curviseta* BROOK were originally extracted from the rhizospheres of field-grown vegetables in Fukushima-City, northern Japan, using a modified Tullgren funnel (FUJIKAWA, 1970). The collembola were maintained and reproduced on cultures of *F. o. cucumerinum* [Tohoku Agr. Exp. Station Stock Culture] and *Cladosporium cladosporioides* (FRES.) DE VRIES (National Institute of Agrobiological Resources Stock Culture 03-05052) in standard Petri dishes containing potato-dextrose agar (PDA) at 15–20 °C.

2.2. Feeding studies

Mycelial disks (2 mm) from cultures of *F. o. cucumerinum* were transfered to fresh plates of PDA, and about 100 insects were introduced onto the mycelium after the air-borne mycelia had developed. Ten replicate plates were prepared. Observations were made on grazing and effects of the fungal food source on insect populations under a stereo-microscope at 50 × magnification over a one week period. General insect behaviour and egg production were also recorded. Control plates contained colonies of fungal species without insects.

2.3. Reduction of infection potential on cucumber seedlings

The fungus *F. o. cucumerinum* was cultured on the excrements (particle size, approx. 2–3 mm) of silkworms in a sterilized Erlenmeyer flask (200 ml) with a cap of an aluminium sheet at 25 °C. When these excrements were fully covered with the mycelia, two tests were carried out. These excrements are termed fungal agents hereinafter. **(1)** Ten grains of these fungal agents were transferred to a cylindrical jar (10 cm in diam., 15 cm in height) with sterilized vermiculite granules (40 g + 80 ml distilled water) of particle size 0.5–1.0 mm. After incubation at 25 °C for ten days, five seeds of cucumber were sown and kept in 25 °C. After the confirmation of infection by *F. o. cucumerinum*, collemboles (300 individuals) were introduced onto the granules. After keeping incubation for ten days at 25 °C, five seeds of cucumber were again sown and kept at 25 °C. **(2)** Together with ten grains of fungal agents, collemboles (300 indivs.) were introduced onto the granules in a jar. After keeping them at 25 °C for ten days, the five seeds of cucumber were sown and kept at 25 °C. All the above procedures were carried out in a laminar flow cabinet to minimize contamination. Control jars contained fungal agents without insects. There were 4 replicates of each treatment.

3. Results

3.1. Feeding observations

S. curviseta readily grazed on air-borne mycelia of *F. o. cucumerinum* during the 1-wk period following release onto the fungal monocultures. Insect feeding prevented or greatly reduced growth of *F. o. cucumerinum*. Individual insects were observed to frequently change feeding sites and move to new areas. After eating the air-borne mycelia, insects ate the agar surrounding the growth of *F. o. cucumerinum*. Each were laid in clusters by several individuals.

3.2. Reduction of infection potential on cucumber seedlings

As soon as the collemboles were added into the jar inoculated with fungi, they moved on seedlings and around vermiculite granules. Within two or three days, the air-borne mycelia growing on the cucumber seedlings were eaten. The cucumbers which were re-sown were not infected by *F. o. cucumerinum*. The seedlings grew healthy and came into flower.

When collemboles were added together with fungi, they also colonized the vermiculite granules and the sown cucumbers were not infected by *F. o. cucumerinum*. The seedlings grew well and came into flower (fig. 1).

4. Discussion

Feeding studies demonstrated that *S. curviseta* feed readily on the cucumber pathogen *F. o. cucumerinum*. Their addition reduced the infection potential of *F. o. cucumerinum* on cucumber seedlings in pot experiments. These results support the findings by WIGGINS &

FIG. 1. BIOLOGICAL CONTROL OF *F. o. cucumerinum* by Collembola in sterilized vermiculite: Unamendend vermuculite (control, left); same with both *F. o. cucumerinum* inoculum and Collembola (right).

CURL (1979) on cotton seedlings and ULBER (1983) on sugar beet seedlings in greenhouse conditions.

S. curviseta, used in the present study, also grazed on *Fusarium oxysporum f. sp. raphani* KENDRICK et SNYDER, *R. solani* and *Rosellinia necatrix* BERL., although its reproduction was fairly low in comparison with that on *F. o. cucumerinum* (MATSUZAKI *et al.*, 1990; MATSUZAKI, 1991).

Collembola can carry mycelial fragments as well as spores in their gut (ANDERSON & HEALEY, 1972; POOLE, 1959), but our previous studies revealed no evidence of *S. curviseta* transporting sufficient quantities of the pathogen *(F. o. cucumerinum)* to new agar media (MATSUZAKI *et al.*, 1990; MATSUZAKI, 1991). WIGGINS & CURL (1979) reported that *F. o. vasinfectum* was readily transmitted by *P. minuta* and *O. encarpatus*.

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Address of the corresponding author: Y. NAKAMURA, Upland Farming Division, Tohuku National Agricultural Experiment Station, Arai, Fukushima, J-960-21, Japan.